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Robt. Fitz Roy

from the Author

1847

—

and to his friend

Captain Lushington —

Augt. 22/47

A LETTER

TO THE RIGHT HONOURABLE

THE EARL OF HADDINGTON,

FIRST LORD OF THE ADMIRALTY, ETC., ETC.,

ON FORMING

A REGISTER OF THE PROPORTIONS AND EQUIPMENT OF SHIPS,

AND OF

THEIR PERFORMANCE AT SEA.

BY JOHN FINCHAM,

MASTER SHIPWRIGHT, CHATHAM DOCKYARD; LATE SUPERINTENDENT OF
THE SCHOOL OF NAVAL ARCHITECTURE.

LONDON:
1842.
[NOT PUBLISHED.]

A.C.H.

Fincham

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A LETTER

TO THE RIGHT HONOURABLE

THE EARL OF HADDINGTON,

ETC., ETC., ETC.

MY LORD:

THAT the science of Naval Architecture is yet below the level which the interests of this country require it should have attained, is too obvious to need any illustration here: I have long entertained this sentiment as a settled conviction. A variety of causes has tended to render the progress of improvement in this branch of practical science slow; some of these obstructions would, from their particular character, require a long series of laborious exertions and deep scientific investigations to remove; there are others which it is conceived might, with less trouble, by careful and attentive observation, and by a prompt application of all the suggestions of experience, have been more readily removed.

Impressed with the importance of this view of the subject, I took the liberty, in the month of June 1832, of addressing to Sir James Graham, then First Lord of the Admiralty, various remarks, the substance of which is contained in the following pages. Ten years further observation, accompanied by as much study as I have had opportunity to give to the subject, has not weakened this conviction. I beg therefore to submit to your Lordship's notice the following observations; and I feel assured that, as the subject to which they relate is duly appreciated by your Lordship, they will receive all the consideration they are entitled to claim.

The progress of improvement in Naval Architecture has been dissimilar to that in various other sciences, in which every deduction of truth aids future investigation, either by confirming and enlarging the data already employed; or, by showing the insufficiency or inapplicability of those data, and giving a decided turn to inquiry. In Naval Architecture, one purely hypothetical course has been hitherto rigidly pursued. In the early stages of investigation, this must be the case; but it is the object of science to ascertain and establish correct and comprehensive data; and, as their sufficiency is tested, to act with invariable reference to fixed principles.

The facts which extensive practice in ship-building has developed, might have been so generalized as to lead to a better acquaintance with the laws which ought to regulate it than has yet been attained. But the want of careful and systematic observation still leaves a deficiency of data, from which alone we could proceed with certainty; and therefore retards the progress of improvement.

Whilst the acknowledged imperfection of ships in various particulars, and the continued alterations that are made in their forms, show that the course hitherto pursued is inadequate to the attainment of the object that is aimed at; it is admitted that theory alone is also insufficient to solve many difficulties that occur in this interesting science. Yet theory, aided by experiment and observation, may be employed with great advantage in promoting the improvement of Naval Architecture.

This progressive advancement must depend greatly on the knowledge we possess of the causes which influence the motions of ships at sea; and while in many cases these causes are so complicated that analytical reasonings are rendered liable to great uncertainty, and it becomes necessary that many points should be practically determined, still there are principles deducible from the laws of mechanical science, which it is probable no species of experiment or series of observations could determine.

The consequences which result from any variation of the proportion and disposition of the parts of a ship, and produce either good or bad effects in the sailing or other essential qualities of a vessel, are in many instances so intricately combined with certain other important considerations, that, with the present imperfect theory, it becomes very difficult to account satisfactorily for many of the remarkable changes that arise from such variations.

In the absence of correct data, doubts must necessarily arise as to the success or failure of any experiment, or the effects likely to be produced by any alteration; and as from the costly nature of any experiment connected with the improvement of ships, recourse can seldom be had to actual trial, to ascertain the consequences of any given condition, we are too frequently left to notions and opinions respecting a vessel's construction and qualities.

By the theory of mechanics, all effects that can arise from the action of forces, however complicated, of which the quantities and directions are defined with precision, may be explained, and any untried plan of construction may be investigated, so as to show what will be the effects on all the essential qualities of the ship; our knowledge of what constitutes the higher excellence of the ship, or whether the form is adapted to produce the greatest rate of sailing, depends on causes too intricately combined for any observations, however extended or diversified, fully to account for them. The data on which the laws of resistances to a ship's motion are founded, are so limited, and consequently the subject is so imperfectly understood, that we cannot rely on any deductions from the present theories for explaining this subject.

While theory or experiment alone is insufficient to explain the difficulties that present themselves in the development of those causes which influence the motions of ships at sea, it would seem that the only method for effectually reducing to system those intricate causes which contribute to impart the greater degrees of excellence to vessels of different descriptions, would be to acquire a perfect knowledge of all the proportions and dimensions of each part of a ship, and to make and record sufficiently numerous observations on the qualities of vessels, in every variety of situation in which ships may be placed at sea. By this means, every voyage a ship makes would be an experiment from which useful truths might be developed. By inferences drawn from repeated observations on the forms, proportions, and equipment of ships, and by attention to their excellences and defects when at sea, faults may be remedied, good qualities improved, and correct rules of practice be established. By investigations of this nature, the qualities of our ships may be traced to their true causes, and ultimately explained by general laws.

To make these experiments would require a close observation and an accurate register of every fact connected with their performance at sea. An analysis of the body, sails, and equipment of a ship, is requisite to obtain the quantities contained in the different elements, so that we may be able in future constructions to draw proper comparisons between different ships. If it be of importance to have the port-sills at a proper height above the water, the proper quantity of displacement must be obtained. If we wish to ensure the easy motion of the ship, and have the decks at their proper pitch, longitudinally; and if it is of importance to determine the proper seat of the ship in the water, the correct adjustment derived from the experience of other ships must be ascertained, for the fore and after bodies. That the lee ports may be at the proper height from the water, when under sail, we must know the requisite stability, and power of sails in terms of the stability. And, in order that a ship may carry a proper helm, we must know the position of the point of sail in relation to the elements of the body; and for a ship to work well, we must know the relation between the fore and after moments of sail to each other. These elements, as well as those given by examples in the Appendix (No. I.), are easily measurable; and having their quantities, we require only to know the limits determined by well-defined experiments, to compare with certainty the qualities of ships.

That the progressive improvement in ship-building should be characterized by the most rigid certainty of which the subject is capable, is no longer a question. The question which now claims to be considered is, What are the means which will lead most directly to that certainty?

The numerous experiments that have been made, and the present means of comparison which the British navy affords, at once suggest the desirableness of a course of observations on the comparative excellences of different ships. In conducting these observations, it will not, however, be sufficient to know that one ship has fore-reached, weathered, or, under some circumstances, been superior to another; but in order to arrive at any useful result, the cause of this superiority must be determined. There may sometimes be great difficulty in ascertaining this fact; but it is obvious that an uncertain conclusion would not answer the end of an experiment. The number of circumstances on which the highest excellences of a ship depend, require that the experiments should be made with great care and discrimination; otherwise it might be impossible to tell whether the superiority or defect in any case has been attributed to the real cause,—such as the position of the masts, trim of the sails, stowage, &c.; or whether it has not arisen from a different mode of management. Incorrect conclusions may likewise be drawn as to the best form submitted to trial, if all the ships are not under the same circumstances as regards the propelling power and the capacity of the body. As the capacity of the body will be determined by the force or number of guns, while the power to carry sail will be in terms of the length and breadth, or nearly so; and as by increased length and breadth the stability may be made greater, with but little addition to the capacity, if one ship has greater dimensions than another of the same force, this ship has a greater power to perform the same work, and the result will be a greater velocity. An example of which we have in the razees, where the same quantity of sail is still retained, in terms of their principal dimensions, while they have, by the reduction, less bulk in the water; or, in familiar terms, they have the same power doing less work, and we observe commonly a greater rate of sailing.

To obtain the greatest advantage in making every ship an experiment, the facts necessary to be ascertained must be more clearly defined, and the quantities more correctly measured, than has commonly been the case at sea. The great anomalies we too frequently find in the reports on the qualities of different ships, not only tend to retard the progress of science, but lead to error. This can only be remedied by having those points for the observation of officers at sea, clearly and accurately defined, and sufficiently extended, which it is hoped the form in the Appendix (No. II.), would, to a considerable extent, ensure. There may be some trouble in making the necessary observations and measurements, but it would accustom the officers to more correct observation, and to take more interest in, and to judge better of, the qualities of their ships.

To enter on a full explanation of all the points recommended for observation at sea, and to show their advantages, would very far exceed the limits of a letter; yet it may not be improper to state one instance, respecting which there is, even amongst the most experienced seamen, the greatest difference of opinion, that of the proper angle for bracing the yards. While some are for bracing sharp, and very properly use every means, by the application of the rigging, to allow of bracing up, others rest contented with the angles of the yards being more open with the line of the keel, considering that they gain no advantage in going to windward by their being sharper. Now, if by an instrument the angle of the main-yard were taken under different circumstances, when all the other sails were touching or lifting with the main-sail, and were entered with the angle of the lee-way, and with the other points named in the proposed register of observation, the matter would be soon decided; and when ships were under trial, by comparing the angles, the advantage of sharp bracing would be rendered quite certain.

It is alone by a multiplied register of facts, compared with an analysis of the body, that we can ever account, on certain principles, for the excellence of one ship over another; all we now know is, that one ship is better than another, but we are still in doubt as to the real cause. That the fame of projectors has been continually changing with the comparative merits of their ships, may be seen by a review of the characters of different ships. In 1765, Sir Thomas Slade built the Victory, a ship of known good qualities, with a length 3,6 times the breadth; and some of the seventy-four-gun-ships which were built in 1786 (with a length 3,58 times the breadth), were of notoriously bad qualities; and if we examine the merits of ships built at more recent dates, we see the same results of the labours of projectors. Sir John Henslow built the Warspite and Illustrious, which were considered good ships, the Fame and the Courageux, which were bad. Sir William Rule built two ships of the same relative length and breadth; the Caledonia, in the year 1808, a good ship; and in 1810, the Impregnable, a bad one: and if we extend our inquiry to the ships built by Sir John Williams, Mr. Hunt, Mr. Bately, or to our more modern projectors, we manifestly see the same differences in the qualities of their ships; which differences, from the want of more correct data, or a standard by which we might compare ships on established and certain principles, have never been accounted for.

If it be true, as is commonly stated, that an apparently trivial alteration in the form of a vessel, in the distribution of the ballast, or the position and extent of the masts and sails, or in some point of management, will wholly change the qualities of a ship from bad to good, or the reverse; and since these changes cannot be attributed to fortuitous causes, it must be allowed that they are the consequences of principles certain and definite; it is therefore of great importance that we should be fully acquainted with the connexion between these causes and effects, which at present is either unknown, or imperfectly estimated by conjecture. Constructors may differ as to the degrees of relative fulness of the fore and after bodies, and as to certain variations in the form; but if we have neither correct observations derived from experiments of the performances of ships at sea, nor correct quantities obtained, of the different elements of the body and sails, to explain the causes of effects which have been observed, we neglect the experimental method of induction, and must be subject to continual error.

The decided difference in the opinions of the most experienced individuals as to the best form for the bodies of ships, shows that it is desirable some fixed principle should be established, as a certain basis for the construction of our ships. The late Admiral Hays and Sir William Symonds, whose attention was directed to this subject at sea, and Sir Robert Seppings, whose situation afforded the greatest opportunity for observation, all held different opinions on the subject, and each gave a decidedly different form of ship, and all were disappointed as to some point of excellence in their ships. It would be easy, from the history of our navy, to point out plans of which there have been the highest expectations, which yet have failed. The projectors of the Inspector, Dart, and Arrow, Courageux, Rapid, and numerous others, were, by departing from the sure and certain track of experimental induction, alike disappointed.

Sir John Henslow, in 1807, built the Warspite with a length 3,67 times the breadth, which ship, according to the reports of experienced officers, was considered good; in 1808, he built the York with an increased breadth, so that the length was only 3,52 times the breadth; and this, according to the account of most officers, was a bad ship. Sir William Rule built the Plantagenet with a small breadth, so that the length was 3,85 times the breadth, and was unsuccessful in his experiment; while, with an increased breadth, as given in the Belleisle, Bulwark, &c., where the length was only 3,68 times the breadth, he was successful; and thus, while one constructor was unsuccessful with an increase of breadth, the other was successful. It must therefore have arisen from some cause, besides the relation of length and breadth, which has never yet been investigated; and the more closely we examine the subject, the more uncertainty or anomaly we shall find; this must always be the consequence of resting on some particular views, instead of following the more certain road of investigation from certain principles. Without the proper quantities contained in the body and sails, in vain do we attempt to account fairly for the superiority or degrees of excellence of one ship over another; each must be compared under circumstances in which she is placed in relation to others; the power of sail with the capacity of the body; the moment of sail with the stability and inclination produced; the parallelopiped contained within the principal dimensions, with the displacement to show the relative fineness; and so on for all the elements; each example when compared with the experiment would give some illustration of the facts obtained. By even comparing the following quantities with the relative velocities of the four under-mentioned ships, we observe under what advantages these were placed in relation to each other as to the impelling power; and we may form a better judgment as to the best form, for we find each of the following ships under different circumstances as to the power of sail:

	Displacement.		Area of Sails.	
Satellite	585	tons,	11500	square feet.
Columbine	518	....	10748	
Tyne	810	....	12656	
Sapphire	872	....	14056	

$$\left.\begin{array}{ll} \text{Satellite} \ldots\ldots\ldots\ldots & \frac{11500}{585} = 19{,}6 \\ \text{Columbine} \ldots\ldots\ldots\ldots & \frac{10748}{518} = 20{,}7 \\ \text{Tyne} \ldots\ldots\ldots\ldots & \frac{12656}{810} = 15{,}1 \\ \text{Sapphire} \ldots\ldots\ldots\ldots & \frac{14056}{872} = 16{,}1 \end{array}\right\} \text{square feet of sail to every ton.}$$

By comparing the displacement with the power of sail, as shown in this example, some idea may be obtained as to the best form. When the relative velocity under trial is known, the resistance, in equally well-formed bodies, would vary according to some law; increasing with the bulk or displacement: and if the management of them, and position of the sails and stowage, and adjustment of the body, were on equal terms, and the bodies of ships equally well formed, as it regards the resistance, the result would have been that the Columbine should have sailed the fastest, the Satellite next, then the Sapphire, and lastly the Tyne; and, in degree, according to the relation between the power of sail and the displacement; and when the velocities are not in a correct relation, it must be attributed to form.

By having the moment of sail and the measure of stability, we see the power each ship has under sail, and may compare that power with the inclinations. By having the centre of gravity of the displacement, with the centres of gravity of the fore and after bodies in relation to their distances from the centre of gravity of the ship, we may observe the relative fulness of the fore and after bodies, and the degrees of fulness at the superior floatation; and examples may be given to show, how the measure of all the elements of the body, sails, &c., may be applied, and the advantage of having them to compare with the results of experiments on different ships. If the adjustment of the body as derived from experiments, and the quantities contained in all the elements of construction, had been known, various examples could be given to show that many tentative alterations that have been made, at great expense, were unnecessary.

It is not less necessary to have the measure of all the elements of the body and sails of different ships in constructing new ships, than when it is required to make any alterations in old ships.

When, in order to render the 18-gun brigs more effective as vessels of war, they were altered into ships, a great saving might have been effected, if proper attention had been paid to our knowledge of known principles, in determining the proper quantities and position of their sails.

In forming a new body, we may have some doubt as to fixing the correct position of sail, from our imperfect knowledge of the resistance of fluids, and consequent difficulty in determining the point of the mean resultant of the water on the body;* but in the case of the 18-gun brig, the experiment had been made, and the proper position and power of the sails had long been known: as it was found expedient to alter them into ships, we had only to bring the centre of sail in the same relation to the body; for the centre of effort must be in the same position, in relation to the mean resultant of the water on the bottom, whatever may be the system of sails, and whether in a brig or ship. But, from not attending to those elements of the brig's sails, as determined by experience, repeated and expensive alterations were made, while the true point ought to have been fixed on before the first alteration.

In the brig, the centre of effort of the sail was ,026 the length of the water-line before the middle, the after moment to the fore moment was ,83 to 1, with an area of sail 9523 square feet, and moment 442413; with the disposition of sail known in the brigs, it ought to have been the same for the ship, to have worked well. To produce, therefore, the same effects when they are ships, the same relative position of sail must be obtained, to preserve the equilibrium, and maintain the necessary qualities of working, except that some allowance may be required for the greater effect of the fore and aft main-sail of the brig over the sails of the mizen-mast of the ship. In the ships, however, under every alteration, we find quite a different result, as may be seen in the following examples:

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* See *Fincham on Masting Ships*, p. 11.

Elements.	Brigs.	First Experiment.	Second Experiment.	Third Experiment.
		Pandora and Victor.	Wasp.	Alert & Sylla.
Area of sail	9523 ft.	8268 ft.	9214 ft.	9603 ft.
Moment of sail..........	432951	348342	418646	452538
Centre of effort before the middle of the water-line	2,6	4,2	3,5	1,73
Fore moment	147262	144676	161433	147239
After moment	123310	109873	128389	163239
Length on the water-line	100	100	100	100

1. *Moment of Stability at* 10° *of inclination* = 409 *tons.*

Brigs .... $\frac{432951}{409} = 1058$

Victor .... $\frac{348342}{409} = 851$

Wasp .... $\frac{418646}{409} = 1023$

Alert .... $\frac{452538}{409} = 1106$

Relative inclining force of the sails under three alterations.

2. *Area of Sails divided by the Displacement. The Displacement 467 tons.*

Brig .... $\frac{9523}{467} = 20{,}4$

Victor.................. $\frac{8268}{467} = 17{,}7$

Wasp .... $\frac{9214}{467} = 19{,}6$

Alert .... $\frac{9603}{467} = 20{,}5$

Number of square feet of sail to every ton of displacement.

3. *Position of the Centre of Effort of the Sails in regard to the Middle of the Water-line.*

Brig .... $\frac{2{,}6}{100} = {,}026$

Victor .... $\frac{4{,}2}{100} = {,}042$

Wasp .... $\frac{3{,}5}{100} = {,}035$

Alert .... $\frac{1{,}73}{100} = {,}017$

Centre of effort of the sails before the middle of the length in terms of the length of the water-line.

4. *Relation of the After Moment to the Fore.*

Brig .... $\frac{123310}{147262} = {,}83$ or fore moment to the after, as $1 : {,}83$

Victor .... $\frac{109873}{144676} = {,}75$ „ „ $1 : {,}75$

Wasp .... $\frac{128383}{101433} = {,}73$ „ „ $1 : {,}73$

Alert .... $\frac{147239}{163239} = {,}9$ „ „ $1 : {,}9$

The examples here given may show the advantage of having the correct quantities, and the necessity of estimating them as it regards the elements of the sails; as, through neglecting them, we observe that several experiments were made before anything near the result was obtained; while, otherwise, a few lines on paper would have determined it with far more correctness than even the last result.

In the 1st case, the moment of sail in the ship was less than that in the brig; and though the error was on the right side as it regards safety, yet we find, as shown in the 2nd case, nearly three square feet of canvas lost by it to every ton of displacement. And, while as brigs they were never considered over pressed, the reduction of canvas or power of sail was unnecessary; and if, as brigs, they were properly balanced on the wind, which was the case, with the centre of effort (as in 3rd case) only ,026 of the length before the middle, after the first alteration, when it was carried to ,042, there must have been a slack helm; and if it required the disposition of the fore and after moment in the brig (as in 4th case), to produce the proper effect in working, they could not have the same power to perform the evolution of staying, as before the alteration.

To give illustrations, to show the application, and to exemplify the advantage of having the elements of the body, as well as of the sails, would not be more difficult, under most of the alterations that may be made in the disposition of the stowage, sails, &c.

In giving examples of the application of correct data to determine effects, it is probable none could be more suitable to the purpose than the razees, from the common seventy-four; as under this alteration we are likely to fall into error without examining the correct quantities.

In cutting down and altering the seventy-four, by taking off the upper works with the batteries, &c., the weight is reduced; weight in the hold, as the shot, water, provisions, &c., is also reduced; and with these reductions other alterations in the disposition of the weights take place, as raising the lower battery, shifting the place of the men, &c., by all which the ship rises bodily out of the water 2 feet, and is reduced in weight about 410 tons.

This would produce a change of the positions of the common centre of gravity and centre of gravity of displacement; and the alteration of each of these elements will affect the stability. There will also be an increased moment of sail by the change of the centre of gravity, and a greater area of sails in terms of the displacement.

In the reduction and alteration of the weights, the centre of gravity of the weight, reduced as estimated, will be about 10,5 feet above the centre of gravity of the ship; and the common centre of gravity of the seventy-four may be assumed at ,2 of a foot above the water: by having the weights removed given, with the position of the centre of gravity, and the whole weight of the ship previous to (2987 tons), and after the alteration (2577 tons), how much the centre of gravity will be removed after the alteration, is easily determined.

Let x be what the centre of gravity will be removed, we have then $x = \frac{10{,}5 \times 410}{2987 - 410} = 1{,}67$. The ship, by the reduced weight, has been raised out of the water 2 feet, the centre of gravity before the alteration ,2 of a foot above the original water-line, then $2 + {,}2 - 1{,}67 = {,}53 =$ the height of the centre of gravity above the new water-line.

To find how far the centre of gravity of displacement is carried down by taking away the lamina between the old and new water-lines, we observe that the centre of gravity of displacement below the centre of gravity of the ship, as a seventy-four, was 8,3 feet, the centre of gravity of the lamina removed out ,95 below the water-line as a seventy-four; therefore $8{,}3 - {,}95 = 7{,}35$ feet, the distance between the centre of gravity of the lamina and that of the displacement. Let y be the quantity the centre of gravity of displacement will go down, we have then $y = \frac{410 \times 7{,}35}{2987 - 410} = 1{,}16$; we have therefore $1{,}67 - 1{,}16 = {,}51$ and $8{,}3 - {,}51 = 7{,}79$ the distance between the centre of gravity of the ship and that of the displacement. In comparing the stabilities before and after the alteration, by taking Attwood's expression, we may obtain the true measure in each case, or the moment of the power it would take to incline the ship through any angle of inclination. The common expression is $\frac{b\,a}{v} - d\,s\,\cancel{v} =$ the measure of stability.

a = immersion and emersion by any inclination.
b = distance of centres of gravity of immersion and emersion.
v = weight of the ship or displacement.
d = distance between the centre of gravity of the ship and centre of gravity of displacement.
s = sine of the angle of inclination.

Stability in the first case as a Seventy-four was at an inclination of 10°.

$b\,a$ = 230001
Cubic Feet. Tons.
v = 104545 = 2987, taking 35 cubic feet of salt water for a ton.
Feet.
d = 8,3
s = ,1736 sine of 10° of inclination.

Hence $230001 - (8{,}3 \times {,}1736 \times 104545) = 79364{,}2$ cubic feet; and $\frac{79364{,}2}{35} = 2267{,}5$ tons, the moment of stability at 10° of inclination; or the moment of any force required to incline the body through an angle of 10°.

Stability as Razee.

$b\,a$ = 221932
Cubic Feet. Tons.
v = 90195 = 2577, taking 35 cubic feet of salt water to a ton.
Feet.
d = 7,79
s = ,1736

Hence 221932 − (7,79 × ,1736 × 90195) = 99957,3 cubic feet; and $\frac{99957,3}{35}$ = 2855,9 tons, the moment of stability at 10° of inclination; or the moment of any force required to incline the body through an angle of 10°.

Moment of Sails in terms of stability as Seventy-four.

Moment of sails, 1750165.

As Razee.

In the razee the height of the centre of effort will be raised 1,67, the quantity by what the centre of gravity is lowered.

The area of the sails will be increased 1211 feet by the increased depth of the courses, &c.

Original area of sails, 22645 feet.

Feet. Feet. Feet.
22645 + 1211 = 23856, whole area as razee. Area 23856 × 1,67 = 39839 = the increased moment. Moment as seventy-four = 1750165; therefore 1750165 + 39839 = 1790004 = whole moment as razee.*

The power to carry sail in the razee will be to that in the seventy-four in the ratio of 2853 : 2280, or it is increased about one-fourth.

The effects of any alteration, as that of partially cutting down a seventy-four, so as to leave two entire batteries under cover; or that of cutting down a frigate, leaving one entire battery under cover, may be calculated by knowing how much the weight of the hull would be reduced by the cutting down, and by ascertaining the distance that the centre of gravity would be removed.

Numerous other examples might be given from which comparisons could be drawn, as the circumscribing parallelopiped of the length, breadth, and mean draught of water, compared with the displacement, to show the relative fineness of the body. The number of cubic feet contained in the circumscribing parallelopiped, if divided by the weight of ordnance, in tons, will show how far the dimensions are suitable for bearing this weight, as compared with different ships; and by it we may likewise institute a comparison with foreign ships, in order to observe the relations between similar classes of those ships and of our own.

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* See Example, *Fincham on Masting Ships*, page 21.

The examples given may be sufficient to illustrate the application of correct data, as a standard of comparison in building ships, and their advantages in explaining the causes of different effects produced under different forms and circumstances.

While the want of more confirmed data and correct observations at sea leaves a shade of uncertainty on the operations of ship-building, the restriction under which projectors were long confined, by the builder's tonnage, was, by making the limits of the principal dimensions for each force too prescribed, one of the greatest obstructions to its progress. Constructors who have been aware of those established principles on which the higher excellence of a ship depends, long held these limitations to be one of the greatest restraints to the full exercise of their professional skill. This led the School of Naval Architecture, about the year 1818, to submit to the Lords Commissioners of the Admiralty several new rules for the admeasurement of ships; and about the same time, when constructing the Volage of 28 guns, and the Rose of 18 guns, and several times since, they showed that under the prescribed limits it was impossible either to give the suitable dimensions for the force, or the proper form. And it is to be hoped that, since those restrictions have been viewed in their proper light, and a greater scope has been given to constructors, the still greater advantages will yet be afforded them, of having in their power the means of extensive reference, by which numerous and accurate comparisons might be made, from which just conclusions might be drawn, and more comprehensive data established. The means for this comparison should comprise the correct quantities of all the elements of the body and sails of different ships of the same class, and a correct register of the facts ascertained, under as great a diversity of circumstances as could be brought together, of the working and performance of ships at sea. Thus, instead of being left to draw conclusions from a few isolated facts (each of which, it is possible, experiments may be found to contradict), they may by a fair and legitimate induction, from observation and experiment, be able to ensure the best dimensions for any given force, and more clearly develop those principles on which the higher excellences of our ships depend. Having by careful deduction from sufficiently comprehensive premises established the proper quantities and the relation of the elements of the body and sails, we might under any variety of form or adjustment estimate the effects to be produced. While the necessity exists of having such a magnitude, under the different classes of three-deck ships, two-deck ships, and frigates, as to prevent the risk of being urged to alter the classes, or of being surprised in future wars by superior ships of other nations, it would be improper to rely on any single element for determining the proper magnitude, or in the relation of any two, as the length and breadth; for we observe equally good performances under proportions very different, as may be perceived in the Caledonia and Victory, Canopus and Gibraltar, Newcastle and Endymion, and very possibly more conspicuously in the old Scourge and Picton.

The insufficiency of data with which constructors are now furnished, renders it impossible for them to ensure the success of their ships; it is therefore hoped that the observations which have been offered, may be sufficient for pointing out the necessity of a more certain mode of constructing our ships, so far as estimating the proper quantities and forming a digest of the different elements of the body and sails, with that likewise of keeping a more correct register of the results of experiments at sea. I would take the liberty to propose that, to form this analysis, calculations should be made on several ships of each rate and class that have been found to possess good qualities, as well as on steam-vessels of different powers, according to the Example given in the Appendix, (No. I.)

The results in this analysis should be formed into tables, so that they might be easily compared with, and applied to any new construction. The tables could be held as Admiralty tables, for the use of the Service only.

To determine the displacement, proper tables of weights should be formed of everything put on board of each rate and class of ship, and the right displacement got for a number of ships of each class, built of different woods. The weights put on board, as given in the Example (see Appendix, No. I.), masts, yards, rigging, stores, &c., may be determined from the different establishments.

However great the advantage may be of every projector having before him the proper elements of construction to ensure his avoiding the errors before alluded to, it is still impossible that any individual can obtain, by his own exertions, sufficient information to form the proposed tables with the proper degrees of correctness, as it is only under the direction of the proper authorities that many necessary particulars can be obtained.

It may be readily perceived that the forming of these tables can never interfere with the views of any projector, or with any means employed for the construction of our ships or steam-vessels; it only affords the means of submitting every design to the test of calculation, to ensure the essential qualities of the ship, and to see that the proper adjustments, quantities of displacement, stability, &c. have been given.

If, my Lord, in this humble attempt to promote the interests of the Service, by establishing ship-building on the same principles which have proved their efficiency by raising other sciences to their present eminence, I may have made any remark that appears to reflect on the professional character of any individual, no reflection has been intended; as when any ship or projector has been named, it has been only to show the defect of a principle generally acted on for the construction of our ships; and should I have failed of bringing this subject with its full importance before your Lordship, I shall only have to regret that I have been unable to do justice to its claims.

I have the honour to be,
My Lord,
With the greatest respect,
Your Lordship's most obedient,
and very humble servant,
JOHN FINCHAM.

Chatham Dockyard, 28*th March*, 1842.

APPENDIX.

(No. I.)

FORM OF TABLE

for showing the Quantities contained in the Elements of the Body, Sails, &c., for comparison in new constructions.

[TWO-DECK SHIPS.]

	Tons.	
1. Burthen in tons (builder's tonnage)	2295	
Register tonnage	..	
	Feet.	In.
2. Length on the range of gun or upper deck, from the aft-part of the rabbet of the stem to the fore-part of the rabbet of the stern-post	196	1½
3. Length of the water-line, from the fore-part of the stem to the after-part of the stern-post	196	9½
4. Breadth extreme to the thickness of the plank of the bottom	51	7½
5. Breadth at the water-line to the outside of the planking..	51	7
.. in terms of the length on the water-line	,26	
6. Height of the port-sills above the deck:—		
Gun-deck	2	3
Middle-deck	..	
Upper-deck	1	11
Quarter-deck and forecastle	1	8
7. Height of the port-sills above the water:—		
A-fore	8	10½
A-midship	6	10½
Abaft	7	3
8. Distance between the ports from centre to centre, at the principal gun-deck	11	4
Ports, fore and aft:—		
Gun-deck	3	4
Middle-deck	..	
Upper-deck	3	3
deep:—		
Gun-deck	2	11
Middle-deck	..	
Upper-deck	2	11
Quarter-deck and forecastle	2	8
9. Height of the under side of the bowsprit, at the fore-part of the stem above the water	18	0

	Feet.	In.
10. Draught of water (load) as calculated to—		
A-fore	21	9
Abaft	24	4
11. Depth of keel and false keel below the lower part of rabbet	1	7
Mean draught of water, in terms of the breadth	,452	
12. Greatest transverse section before the centre of gravity of displacement	8	10
13. Greatest transverse section before the centre of gravity, in terms of the length	,045	
14. Area of the greatest transverse section, in square feet	917	0
15. Area of load-water section, in square feet	8847	0
16. Area of the vertical longitudinal section, in square feet	4556	0
	Tons.	Cwt.
17. Light displacement (weight of hull)	1793	0
18. Quantity of ballast	229	13
19. Ordnance on lower deck :—	..	
.. .. Long guns, number	26	
.. .. Pounders	32	
.. .. Weight, each	56 cwt.	
.. .. Shell guns, number	6	
.. .. Pounders	68	
.. .. Weight	65 cwt.	
.. Middle deck ; long guns, number	..	
.. .. Pounders	..	
.. .. Weight	..	
.. .. Shell guns, number	..	
.. .. Pounders	..	
.. .. Weight	..	
.. Upper-deck ; long guns, number	30	
.. .. Pounders	32	
.. .. Weight	48 cwt.	
.. .. Shell guns, number	2	
.. .. Pounders	68	
.. .. Weight	65 cwt.	
.. Quarter deck; long guns, number	6	
.. .. Pounders	32	
.. .. Weight	41 cwt.	
.. .. Carronades, number	16	
.. .. Pounders	32	
.. .. Weight	17 cwt.	
.. Forecastle ; long guns, number	2	
.. .. Pounders	32	
.. .. Weight	41 cwt.	
.. .. Carronades, number	4	
.. .. Pounders	32	
.. .. Weight	17 cwt.	

	Tons.	Cwt.
20. Total weight of ordnance	229	0
21. Quantity of water, in gallons	79744	
Weight in tons	356	0
Wood	6	0
Coals	82	0
Slops	5	0
Soap	1	0
Candles	1	0
22. Tare of casks and tanks	19	0
23. Weight of provisions, in tons	169	0
Men and effects	80	0
24. Weight of main-mast, top-mast, top-gallant-mast, and yards, in tons	34	15
.. Fore ditto	28	15
.. Mizen ditto	11	5
.. Bowsprit, jib-boom, and flying jib-boom, ditto	13	0
.. Rigging and blocks on main-mast, ditto	24	13
.. .. Sails, ditto		
.. .. Fore-mast, ditto	20	7
.. .. Sails, ditto		
.. .. Mizen-mast, ditto	5	12
.. .. Sails, ditto		
.. .. On the bowsprit, ditto	5	2
.. .. Sails, ditto		
.. Spare gear, ditto	14	14
.. „ Sails	5	12
.. Carpenter's stores, ditto	52	0
.. Boatswain's stores, ditto		
.. Round shot, ditto		
.. Shells	24	0
.. Grape and canister shot, ditto	11	0
.. Powder ditto	36	0
.. Remainder of gunner's stores, ditto	38	0
.. Boats, ditto	11	0
.. Anchors, ditto	21	4
.. Chain cables, ditto	38	0
.. Hempen cables, ditto	16	4
.. Iron stream, ditto	2	2
.. Hempen stream, ditto *	1	15

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* It is necessary to have the table of weights separated, as much as possible, for readily determining their correct moments for placing the ballast; without the moments, the distribution of the ballast must be conjectural, as to bringing the ship to her correct water-line; and while, by constant observation on the form and stowage of different ships, the trim may be obtained nearly, there is still, however, without the moments, considerable uncertainty.

25. Total displacement, in tons	3562
26. .. cubic feet	124670
Quantity of ballast, in terms of the displacement	,0643
27. Displacement before the centre of gravity, in cubic feet	62904
28. Displacement before the centre of gravity, in tons	1797
29. Displacement abaft the centre of gravity, in cubic feet	61766
30. Displacement abaft the centre of gravity, in tons	1765
31. Depth of centre of gravity of the greatest transverse section below the load-water-line, in feet	9,4
32. Depth of the centre of gravity of displacement below the load-water-line, in feet	8,42
33. Distance of centre of gravity of displacement from the middle of the length, at the water-line, taken between the fore-part of the stem and the after-part of the stern-post	2,7
Distance before the middle of ditto, in terms of the length	,0137
34. Distance of the centre of gravity of the load-water-line, from the centre of gravity of displacement	2,54
35. Distance of the centre of gravity of the solid that is before the centre of gravity of displacement, before the said centre	37,2
36. Distance of the centre of gravity of the solid that is abaft the centre of gravity of displacement, abaft the said centre	37,88
37. Solid immersed to an inclination of 5°, in cubic feet	..
.. .. 10°	9287
.. .. 15°	..
38. Distance of the centre of gravity of the solid immersed from the centre of gravity of displacement, to an inclination of 5°	..
10°	1,65
15°	..
39. Solid emerged by an inclination of 5°, in cubic feet	..
.. .. 10°	9163
.. .. 15°	..
40. Distance of the centre of gravity of the solid immersed from the centre of gravity of displacement, at an inclination of 5°	..
10°	1,33
15°	..
41. Distance of the centre of gravity of the vertical longitudinal section abaft the centre of gravity of displacement	6,5
42. Height of metacentre	13,81

43. Measure of stability, calculated agreeably to Attwood's expressions, at an inclination of 5°	Feet. ..
10°	,974
15°	..
44. Moment of stability. Displacement multiplied by the measure as above, at an inclination of 5°	Tons. ..
10°	3469
15°	..
45. Fore-mast before the middle of the length of the water-line	Feet. 74,66
Ditto .... ditto .... in terms of the length ..	,379
Ditto .... to rake in 12 feet	00
46. Main-mast abaft the middle of the length on the water-line	11,8
Ditto .... ditto .... in terms of the length ..	,06
Ditto.................. to rake in 12 feet	4 in.
47. Mizen-mast abaft the middle of the water-line	63,0
Ditto .... ditto .... in terms of the length ..	,331
Ditto .... to rake in 12 feet	7 in.
48. Bowsprit to stive in 12 feet	72 in.
49. Area of sails, in square feet............................	27595
50. Moment of sails	2315308
51. Centre of effort before the centre of gravity of displacement, in feet	6,5
Ditto, ditto, in terms of the length on the water-line..	,033
52. Height of the centre of effort of the sails above the load-water-line, in feet	84,0
53. Moment of effort of sails abaft the centre of gravity	618196
54. Moment of effort of the sails before the centre of gravity	870240
Fore moment to after moment..................... as	1 : ,71
55. Area of sails abaft the centre of gravity, in square feet ..	17255
56. Area of sails before the centre of gravity, in square feet ..	10340
57. Displacement in proportion to the circumscribing rectangular parallelopiped contained by the length on the water-line (from the fore side of the rabbet of the stem to the after-part of the rabbet of the stern-post), breadth at the water-line, and mean draught of water to the lower edge of the rabbet of the keel .... as	1 : ,57
58. Area of load-water section in proportion to a circumscribed rectangle contained by the length and breadth on the water-line .... as	1 : ,87
59. Area of midship section in proportion to a circumscribed rectangle, contained by the breadth at the water-line, and depth from the water-line to the lower side of the rabbet of the keel .... as	1 : ,83

60. Comparative moment of the sails in relation to the stability	669
61. Weight of ordnance in proportion to the circumscribed rectangular parallelopiped of length, breadth, and depth, showing the number of cubic feet to a ton weight of ordnance	1099,5
62. Effective force of ordnance in weight	2976 lbs.
Surface	..

Note.—This Table is given as an example for one ship only; but it is desirable to have similar Tables formed for several ships of each class, with the addition of such other elements as may be subjects of useful comparison, to guide the constructor in his calculations for the construction of other ships of the same class. In the absence of the means of this general comparison, there can be no certainty in the construction of ships, and every deviation from previous example can be only a new experiment; without, however, the means of determining with certainty what are those particular elements which constitute the excellence, and in many cases, the defects of a ship.

It is also desirable that similar Tables should be formed for the different classes of Steam-vessels, adapted to all the peculiarities of that description of vessels, with a view to determine the comparative excellence or deficiency of each; and to discover what are the character and proportions of those elements which constitute the best qualifications of the vessel.

Quantity contained in the different Elements of the body of Steam-boats, with weight, power, speed, &c., of the Engine; for the use of the Naval Architect.

1. Length from the aft-part of the rabbet of the stem to fore-part of the rabbet of the stern-post, at the height of the upper deck	
2. Length on the water-line	
3. Length of the engine-room	
4. Breadth extreme	
5. Breadth to the outside of the plank of the bottom	
6. Breadth moulded	
7. Breadth at the water-line to the outside of the plank	
.. in terms of length on the water-line	
8. Breadth of rudder at the lower part	
9. Rise of the floor in half the extreme breadth	
10. Depth in hold in engine-room to the upper side of sleepers	
11. Depth of sleepers to the upper part of the keelson	

12. Depth of the keel and false keel below the rabbet ......
13. Height of the deck at the side above the water a-midships when fully equipped, water in boilers, and coals on board ......
14. Height of the deck at stem above the water ......
15. Height of the deck at the stern-post above the water ....
16. Height of the centre of paddle-shaft above the water when deep ......
17. Greatest transverse section before the middle ......
18. Centre of shaft before the middle of the length of the water-line ......
Centre of shaft before the middle, in terms of the length
19. Diameter of paddle-wheel ......
20. Breadth of paddle-wheel ......
21. Breadth of the paddles ......
Area, ditto ......
22. Dip of the paddle in the water when completely equipped
Number of radii ......
23. Light draught of water:—
A-fore......
Abaft ......
24. Load draught of water when fully equipped, with coals in, and water in the boilers:—
A-fore......
Abaft ......
25. When in best trim:—
A-fore......
Abaft ......
26. Horse-power of engines ......
27. Light displacement in tons ......
28. .... cubic feet ......
29. Weight of boilers * ......
30. .. water in boilers ......
31. .. cylinders and parts connected ......
32. .. paddles, paddle-shaft, and frame ......
33. .. air-pump and hot-water cistern; and furniture connected ......
spare gear ......
34. .. coals, when full in the boxes ......
.. .. not in boxes ......

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* To have the weights of the most ponderous parts of the engine, boilers, &c., is of considerable consequence, in order to obtain their exact moments, for the purpose of bringing the boat to the proper trim. It is from the neglect of a proper attention to the position of these weights that there is frequently a defect in boats, there being either too much by the head or the stern, which requires to be regulated by the moveable weights.

35. Weight of ballast, if any ....

36. .. water and provisions ....

.. men and officers, and their effects............

37. .. masts, rigging, sails, and stores ....

.. anchors and cables ....

.. boats ....

38. .. ordnance and stores ....

.. engineer's stores ....

39. .. load displacement, in tons ....

.. .. cubic feet...............

40. Centre of gravity of light displacement before the middle* ....

41. Centre of the boilers, abaft the middle..................

42. .. cylinders, before the middle ....

.. air-pumps .. ..

43. .. coals, from middle ....

44. .. ballast, if any ....

45. .. gravity of displacement, before the middle ..

46. Distance of the centre of gravity of the solid that is before the centre of gravity of displacement from the said centre ....

47. Distance of the centre of gravity of the solid that is abaft the centre of gravity of displacement from the said centre ....

48. Depth of the centre of gravity of displacement ....

49. Area of load-water section ....

50. Distance of the centre of gravity of ditto, before the middle

51. Area of the greatest transverse section ....

52. Depth of the centre of gravity of ditto ....

Ordnance .. .. Number........

Pounders ......

Weight ....

Length of the stroke of the engine ....

Diameter of cylinder ....

Common number of revolutions of the paddle-wheel per minute, when light ....

Ditto, when deep ....

Common velocity of the boat under these revolutions, in smooth water ....

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* This is an element that requires to be obtained for regulating the trim, and placing the engine.

APPENDIX. (No. II.)

Note.—*Observations to be made and entered daily, or as often as the state of the wind and sea may be favourable to experiment.*

Note.—*Angle of the main-yard to be taken when all the other sails are touching with the main-sail.*

REPORT OF OBSERVATIONS MADE WHEN SAILING CLOSE-HAULED.

REMARKS.	Date.	Power and state of the wind.	Rate of sailing.	Points near the wind.	Main yard braced to an angle of	Angle of lee-way.	Common inclination.	Angle of pitching.	Angle of scending by the stern.	Times of pitching from and to an horizontal line.	Times of scending from and to an horizontal line.	Helm carried.	State of the sea.	SAIL SET, WITH REMARKS.
	1833 Apr. 23		6	5½	22°		7½°	7°	4°	5″	5″	Not quite ¼ a-turn a-weath	Smooth water.	Courses and royals, first reef in.
	29		6.4	6	22° 30′		7½			3.3″	3.3″	¼ a-turn a-weath	A head sea.	Single reefed main, double reefed fore, and mizen top-sail, top-gallant-sails, and jib; and reefed driver.

Note.—Having the force of the wind, points near the wind, common inclination, &c., with the sail set, the stability of the body at different inclinations may be determined at any period, by the Naval Architect.

Note.—By having the angle of lee-way, points near the wind to which the ship lies, and the angle to which the yards are braced, we may not only draw a more correct conclusion as to the weatherly qualities of the ship, but come to some decision as to the best angle of bracing the yards, with the different states of the wind and sea.

Note.—The angles of pitching and scending will, to a great degree, determine how far the ship is relatively too full forward or aft; and by having the times of the oscillations, we may ultimately draw some conclusion as to whether the weights are properly concentrated or extended, when compared with elements of the body (that show the buoyancy of the body forward and aft). For as the angular inertia is diminished or increased (while the water-line remains the same), so will the ship pitch or scend more or less quickly.

Note.—The quantities under each heading, as given in the above Table, were taken under experiment, on board the Winchester, of 50 guns.

NOTE.—*Observations to be made and entered daily, or as often as the state of the wind and sea may be favourable to experiment.*

NOTE.—*Angle of the main-yard to be taken when all the other sails are touching with the main-sail.*

OBSERVATIONS MADE WHEN SAILING ONE POINT FREE.														
REMARKS.	Date.	Power and state of the wind.	Rate of sailing.	Main-yard braced to an angle with the keel.	Common inclination.	Arc passed through in lurching.	Times of describing arc.	Angle of pitching.	Angle of scending.	Times of pitching from and to an horizontal line.	Times of scending from and to an horizontal line.	Helm carried.	State of the sea.	SAIL SET, WITH REMARKS.

Note.—See Notes, p. 33.

NOTE.—*Observations to be made and entered as often as the state of the wind and sea may be favourable to experiment.*

OBSERVATIONS MADE WHEN SAILING WIND A-BEAM.										
REMARKS.	Date.	Power and state of the wind.	Rate of sailing.	Main-yard braced to an angle with the keel.	Common inclination.	Angle of the greatest lurch to leeward.	Angle of the greatest lurch to windward.	Time of rolling from and to the greatest lurch each way.	State of the sea.	SAIL SET, WITH REMARKS.
	May 9		10	28° 3′	7°	9°	5°	6″	Very smooth water.	Every stitch that could be set, all the starboard studding-sails, including lower and main topmast, and three staysails; all the reefs out.

Note.—The angles of rolling or lurching will be more or less deep, and the times more or less quick, according to the form of the body between wind and water, and the momentum of inertia, or the square of the distance of all the weights from the centre of gravity of the body. By having the time and quantities that may be supplied by the measurement of the body, the moment of inertia may be determined; and it is possible, that the principles on which the easy motion depends, may be more clearly defined, and the distribution of the ballast and other weights, with the quantities of immersion and emersion of the body regulated accordingly, so that the ship's motion may neither be so quick nor so deep as either to endanger the spars or prevent the proper degrees of precision in fighting the guns.

NOTE.—*Observations to be made and entered as often as the state of the wind and sea may be favourable to experiment.*

OBSERVATIONS MADE WHEN SAILING WIND ON THE QUARTER.										
REMARKS.	Date.	Power and state of the wind.	Rate of sailing.	Main-yard braced to an angle with the keel.	Common inclination.	Angle of the greatest lurch to leeward.	Angle of the greatest lurch to windward.	Time of rolling from and to the greatest lurch each way.	State of the sea.	SAIL SET, WITH REMARKS.
	1833 May 10	Strong breeze	11	47°	4°	8½°	4°	9″	Smooth, considering the breeze.	Courses, double-reefed top-sails, top-gallant-sails, main and fore top stay-sails; no jib or driver.
	14	Moderate breeze.	10.4	45° 25′	2°	7°	5°	5″	Very smooth.	Courses, single-reefed top-sails, fore-top-gallant, and fore and main top-gallant-sails, studding-sails, royals, stay-sails, flying-jib, and driver.

Note.—See Note, page 35.

NOTE.—*Observations to be made and entered as often as the state of the wind and sea may be favourable to experiment.*

OBSERVATIONS MADE WHEN SAILING BEFORE THE WIND.							
REMARKS.	Date.	Power and state of the wind.	Rate of sailing.	Angle of rolling.	Times of rolling through the greatest inclination each way.	State of the sea.	SAIL SET, WITH REMARKS.

Note.—See Note, page 35

NOTE.—*Observations to be made and entered at such times when it may be necessary to stay or wear the ship, when she is lying-to in a gale of wind, or at anchor, when the state of the sea is suitable to experiment.*

OBSERVATIONS ON THE MANNER IN WHICH THE SHIP WORKS.				
REMARKS, When riding at anchor, and lying-to in a gale of wind.	Date.	State of the wind and sea.	REMARKS, When wearing or staying.	Quantity of sail set.

Note.—It is important that Naval Architects, when they are comparing the elements of the body with the position of the masts and sails, should know whether, when the ship is in stays, she pays off, or whether she comes to the wind properly; whether, when she comes to the wind readily, she falls off again; and whether she pays off too much after she is round, &c.: as these circumstances may be regulated by the relative position of the fore and after moments of sail. The ship may carry a good helm when by the wind, and yet the head and after sails may not be in such a relation to each other that the ship will work properly.

NOTE.—*Observations to be made in Steam Vessels, whenever opportunities may be favourable to experiment, and entered at the same time, for the use of the Naval Architect.*

Dates of experiment.	WIND.		State of sea.	SPEED OF VESSEL.			What sails set.	Revolutions of wheel per minute.	Height of steam-gauge.	Height of barometer gauge.	Angles of rolling.	Times of rolling from and to an horizontal line.	Greatest angle of pitching below an horizontal line.	Times of pitching from and to an horizontal line.	Greatest angle of scending below an horizontal line.	Times of scending from and to an horizontal line.	Draught of water, as near as it can be ascertained.	Dip of paddle.	REMARKS.
	Power.	Direction, as it regards the vessel.		Steaming only.	Steaming and sailing.	Under sail only.													

Note.—These observations are not intended to interfere with the present log and registers.

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Note.—In addition to the foregoing forms, it would be desirable that a correct register should be kept of the draught of water, stowage of hold, and removal of any of the weights, that it may be more readily determined what was the trim of the ship when any experiment was made; as a ship may answer well, or act badly; and, owing to the roughness of the sea, it may be some time before the draught of water and trim can be taken; and during that period a considerable consumption of water and provisions may be made.

The instruments that will be required for making the experiments proposed in the foregoing Tables are of simple construction, easy application, and of small expense.

APPENDIX. (No. III.)

The object of the foregoing Tables is to obtain a correct statement of the performance of ships at sea, and thereby to supply facts for extended comparison; that by ascertaining the due proportions and just relations of all the essential properties of a ship, they may be ensured in the construction of new ships. But the durable qualities of a ship are not less important than its working qualities; whence it is desirable to institute and register another course of strict observations, in order to become acquainted with the working and yielding of every part of the structure, and with the causes of all the defects that occur. This Register should, therefore, include all the facts of premature decay, and the extraordinary working and yielding in any part of the ship, with a statement of the causes of such defects; and also notices of extended durability in any part. And a copy of this full and detailed report of facts should be transmitted, from the Yard in which the observations are made, to all the other Dockyards, and registered in each Yard, in alphabetical order. By this means much valuable information would be supplied; which, under the present system of reporting only the most material defects, can never become general. And even the notices of these defects, by being involved in an accumulation of general reports and orders, soon become useless.

Though the observations made by the shipwright officer who superintends the repairs increase his own experience, yet they are often of no further use; but the plan of registration which is submitted, would render this information generally available throughout the whole Service. Now this body of information, drawn from all the sources which are open in the different Yards, might be systematically arranged, and a reference to any useful fact made perfectly easy by an alphabetical index. The usefulness of the Register would depend greatly on keeping it in a systematical order. For if there should be observed, on the opening of a ship under repair, where two species of materials had been used, either an extended durability, or a premature decay; or an excessive action in any part of the frame, it might be desirable to ascertain what was the state, in similar combinations, in other ships. And by collating a number of similar facts, with their accompanying circumstances, just conclusions might be drawn,—a repetition of the error which occasioned any defect avoided; and any particular circumstances which were found to have contributed to the durability of any part of the structure, on becoming generally known, might be made necessary conditions in the construction of new ships. It would likewise have the beneficial tendency of inducing a more rigorous inspection of every defect that might be discovered in ships under repair.

The Register should be kept under six general heads: premature decay, great durability; unusual working, firm combination; excessive wear, comparatively small wear. These general heads should have two columns; one for the *facts*, and the other for the supposed causes and remarks. Under the six heads, the different parts or materials should be arranged alphabetically.

Examples.

SHIP'S NAME.	FACTS.	REMARKS ON ACCOMPANYING CIRCUMSTANCES.
	PREMATURE DECAY.	
	Frame.—Timbers in the after cant body of *African*, quite rotten.	The range of fibre was crossed by the curvature, and heart of the tree brought in the back of the timber.
	Step, Fore.—Quite rotten, in three years.	A great deal of filth swept into the hold from the decks.
	Planking: Main Wales.—The edges quite rotten in the middle.	In re-caulking the seams, new oakum had been driven on wet oakum.
	EXCESSIVE WEAR.	
	Deck, Flat, of fir, worn one inch in three years and a half.	Excessive scraping and use of the holy stone.
	Bolts.—Chain very much worn.	This was supposed to be occasioned by the plate, which being in one, and having no links, as the common chain, brings the whole of the working caused by the motion of the ship on the chain-bolts.
	Pins that secure the dead-eyes to the chain-plate, very much worn.	In consequence of the eye at the end of the chain-plate not being sufficiently wide to afford a proper bearing, the constant motion produced an excessive working upon the pins.

Note.—The same tabular form may be used for the purpose of noting any practical difficulties or advantages that may present themselves in the building of ships, with the view of perfecting the system of building.

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